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ABSTRACT

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Additive Effects From Interspersed Adjunct Questions In Prose Text

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Paper presented at the annual meeting of the American Educational Research Association. New York City, 1977.

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Abstract

A total of 150 undergraduate students randomly assigned to five experimental groups studied ten paragraphs with questions interspersed at different locations in the text. Performance on incidental items was significantly lower ($p<0.05$) in the question before (QB) than in the question after (QA), question before and after (QBA), and the no-question (NoQ) groups. Performance on intentional items by the QB subjects was significantly lower ($p<0.05$) than the QA and QBA subjects. The results also suggest that (a) the QB and QA effects of questions combine additively to produce the performance of the QBA subjects, and (b) the attention operation is equivalent across conditions for intentional items, but differs in retention operation. This may mean that depth-of-processing is the relevant operation to focus upon.

During the past decades of research on mathemagenic behaviors, at least three theoretical orientations have emerged to explain diffential outcomes of variables associated with the type and placement of adjunct questions: (1) The "mathemagenic behaviors" view, introduced by Rothkopf (1965), claims that the learners' inspection behaviors are adaptive and shaped by extinguishing non-productive (unsuccessful) behavior and strengthening productive (successful) behaviors. (2) The cybernetic model (Frase, 1969) suggests that the learner determines whether or not achieved behavior (what is place in memory) coincides with the terminal criterion (the correct answer). The consequence of positive feedback is maintenance of the successful strategy, whereas the consequence of negative feedback (failure to answer test questions correctly) is alteration of the strategy applied to subsequent paragraphs. (3) A third framework hypothesizes the existence of two operations (Boyd, 1973): (a) attention, that is, the process of putting information into some form of storage which becomes operational in immediate or nearly immediate recall of information; and (b) retention, that is, holding the material in storage over time.

The latter frameword (Boyd's) is the one within which the present study was conducted. This position indicates that prequestions cue the learner to attend more to

intentional material than to incidental material, but the forgetting rate for both types of material will be the same once the material has been stored. Accordingly, prequestions are assumed to influence selective attention but not selective forgetting. Postquestions, on the other hand, are said not to influence attention and retention of incidental material any differently than the noquestion treatment, but do enhance retention and the retrieval of intentional material. On the basis of such considerations, and evidence supporting them, Boyd speculated that the combination of pre- and postquestions should be additive in its effects. Thus,

> . . . if prequestions increase a subject's attention for intentional material and postquestions retard the rate of forgetting for material attended to, then the effect of giving a set of prequestions with identical postquestions should be to increase intentional posttest scores more than a set of pre- or postquestions alone . . .. (p. 32)

Support for this view was obtained through the failure to find an interaction between type-of-learning and average performance on an eleven-treatment-matrix.

Based on the attitive model proposed by Boyd, we were concerned in the present study, with the combined effects of pre-and postquestions. Our hypothesis was that the combination of pre- and postquestions would result in performance on a posttest which was equivalent to

performance attributable to prequestions alone, plus performance attributable to postquestions alone. In order to test this hypothesis adequately, several methodological provisions, most of which have been neglected in previous studies, were incorporated into the design and procedures. These provisions were as follows:

1. In order to enhance the generalizability of results to a general college population, a heterogeneous sample of college students from a variety of sources, (i.e., majors, colleges, sex, and year in school) were enlisted as subjects. In this regard, we note that sampling in the past was often made from homogeneous target populations such as college suphomores in introductory psychology, office workers, or paid volunteers. To further enhance generalizability, the tasks in the present study were administered under naturalistic study conditions.

2. The items for the adjunct questions and for the criterion tests were selected at random from an item pool which represented the knowledge domain of the entire passage. The result of this procedure was that 30 different forms of the test were employed and these were randomly administered to subjects.

3. Defined procedures were employed in the placement of adjunct questions within the text. The same items were used across the five experimental treatments (i.e., same question

was the prequestion in the QB condition, was the postquestion in the QA condition and was the prequestion in the QBA condition. The QBA condition also had a different randomly selected item place after the passage.). The posttests were the same across the five treatments.

4. In order to provide for comparison of results with previous studies, provision was made for replication of basic effects in the design.

Stimulus Material and Item Selection Procedure

The reading passage was approximately 800 words long and dealt with the topic of vitamins. It was divided into ten paragraphs, each of which was comprised of seven sentences. Each sentence contained a single main idea. Open-ended questions which could be correctly answered with one-to-three words were constructed for each of the 70 sentences, thereby defining a large percentage, if not all, of the population or "domain" of ideas represented in the passage. Each paragraph contributed seven questions to the item pool. They will be considered subpools of questions representing "subdomains" of ideas.

Through the use of computer text processing programs, forty questions were randomly selected from the domain of items for the adjunct questions and for the postreading criterion measure. A set of forty items equally represented

(n=4) each of the ten paragraphs or subdomains. The randomization procedure specified the random number generator to repeat questions across treatments. The order of the questions in the criterion measure was further randomized to reduce the likelihood that any one item could be answered because of primacy or recency effects, because it duplicated the sequence of material within the passage, or because of other similar but unidentified artifactual effect. Each subject within a given condition received a unique set of questions but the same set of questions appeared across conditions, thereby, providing a replication of items across treatments. As already indicated, this procedure resulted in thirty different forms of the test and sets of adjunct questions.

Procedure

Students enlisted for an experimental session convenient to their study schedules. General instructions were given to a group of subjects (ranging from 5-7 students), after which each found a place where he/she could be alone and might be comfortable studying (this could conceivably be ones residence hall room). As each subject finished studying the self-administered stimulus material, he/she exchanged it for the criterion measure. Subjects were "closely" monitored to ensure that directions were being

followed.

RESULTS AND DISCUSSIONS

The initial concern was, to test if the criterion measure produced by the random item selection procedure were equivalent. The 30 x 5 ANOVA failed to reject the hypothesis of equivalent tests (all p's were greater than 0.58). Since the hypothesis of equivalent criterion measures cannot be rejected, neither can we reject the hypothesis that the item selection procedure produced equivalent test. The importance of this finding is that the results cannot be attributed to test biases, but may be attributed to the treatment to which each subject was exposed.

Closely associated with equivalent tests was the necessity to determine whether the materials were appropriate for the target population, as well as to identify the knowledge base of the topic for this population. The "test-only" scores (Table 1) proved to be significantly lower ($p<0.01$) than the remaining scores. The "test-only" subjects are therefore considered a control group. Likewise, we can assume that any change from this population base knowledge is attributable to the particular treatment to which subjects were exposed.

A second concern was, whether our data could replicate the differential effects produced by previous investigators

with respect to intentional and incidental performance scores. A 2 x 4 ANOVA with two levels of type-of learning (intentional and incidental) and four levels of question-placement was conducted. A significant interaction of the two variables yielded, $F(3,116)=19.96, p<0.01$. Therefore, follow-up procedures, via the Newman-Keuls Tests, were used to test for simple effects in order to detect the loci of the interaction. Intentional learning performance was found to be significantly higher ($p<0.01$) than incidental learning performance for all groups (except for the NoQ group, of course). The same analysis as above was carried out excluding the NoQ condition, indicated no interaction but a significant difference resulted ($p<0.01$) between intentional and incidental effects for all groups (Figure 1). In concert with past findings, no significant differences resulted on intentional scores between QA and QBA but were significantly different than the QB scores. For the incidental scores, the QB group again performed significantly lower ($p<0.05$) than the remaining groups. The incidental scores of the subjects in the NoQ, QA and QBA were found to be equal to the NoQ and QB scores.

Within the mathemagenic behaviors' viewpoint, we wanted to ascertain if performance increased across serial order presentation of paragraphs. That is, does questioning produce adaptive behaviors? Conducting a 2 x 2 ANOVA test,

with two within-subject factors, (perfomance on paragraphs 1-5 versus performance on paragraphs 6-10 and incidental versus intentional learning) postquestioning was the only treatment to produce diverging performance, thereby producing an interaction between the two factors, $F(1,29)=10.01, p<0.04$. The displacement of the crvea for these data, shown in Figure 3, indicates that the QA condition leads the learner to perform at a higher level in the latter half of the material than on the first half for intentional questions. The incidental questions produce the reverse trend.

The main focus of this study was, of course, to test whether there was support in the data for the additive performance model. The model, depicted in Equation 1, was confirmed, by failure of the data to produce a significant interaction between QB, QA and QBA intention and incidental scores.

$$\begin{aligned} NoQ + (QB - NoQ) + (QA - NoQ) &= QBA \qquad (1) \\ 64.08 + (69.7 - 64.08) + (79.0 - 64.08) &= 83.92 \end{aligned}$$

As a check, the equation was applied to each replication. The actual mean score of the QBA subjects was 77.83, which did not depart significantly from the hypothesized, predicted, value of 83.92. The implication of

this finding is that the effects of the QBA treatment approximates the effects of the additive combination of QB and QA, according to the additive performance model.

A fourth concern of this study was to investigate if attention ensures retrieval of information, as implied in previous studies (i.e., Boyd, 1973). In order to provide for this, the experiment was designed to have each subject write the questions immediately after reading the paragraph. The data imply that our treatments affect attention equally, but affect encoding of the material differently, that is depth-of-processing. The QBA organization of material implies that the learner can and does use advantageously the unique processes influenced by both prequestioning and postquestioning treatments. The beneficial processing by the QBA would most likely show up in a test for the retention of information over an extended period of time (a more realistic aim of education). Thus, better performance over time, due to the more thorough processing of the material would lead us to conclude that pre- and postquestioning condition lead to "processing advantage" not found in other conditions, singly.

Conclusions

From the evidence produced by this study, the following can be concluded:

1. Questioning does influence processing of information.
2. The additive effects of pre- and postquestioning are due to prequestions cueing the learner to a single source of information, while the postquestion has the affect of reorganizing as well as providing retrieval cues for the learner.
3. The data imply equivalent attention operation but differential encoding process, thereby, making available the information for later retrieval. That is, it affects both encoding specificity and depth of processing.

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TABLE 1

Average Performance[1] For Each Set of Questions

QUESTIONS	Treatment				
	Test-only	NoQ	QB	QA	QBA
Total Incidental Questions	16.6	64.08	40.6	58.6	60.2
Total Intentional Questions	16.6*	64.08+	69.7	79.0	77.8
Total Questions	16.6*	64.08	47.9	63.8	69.0

[1]Performance is measured in percent of correct responses.

*Subjects in the "test only" condition were not exposed to the stimulus material, but were given the criterion test. Items only in the final test, by definition, measure incidental effects, but are assumed to measure intentional effects as well in the control group.

+All items in the NoQ treatment group measure incidental effects by definition, however, the intentional score is assumed to be equal to that of incidental items.

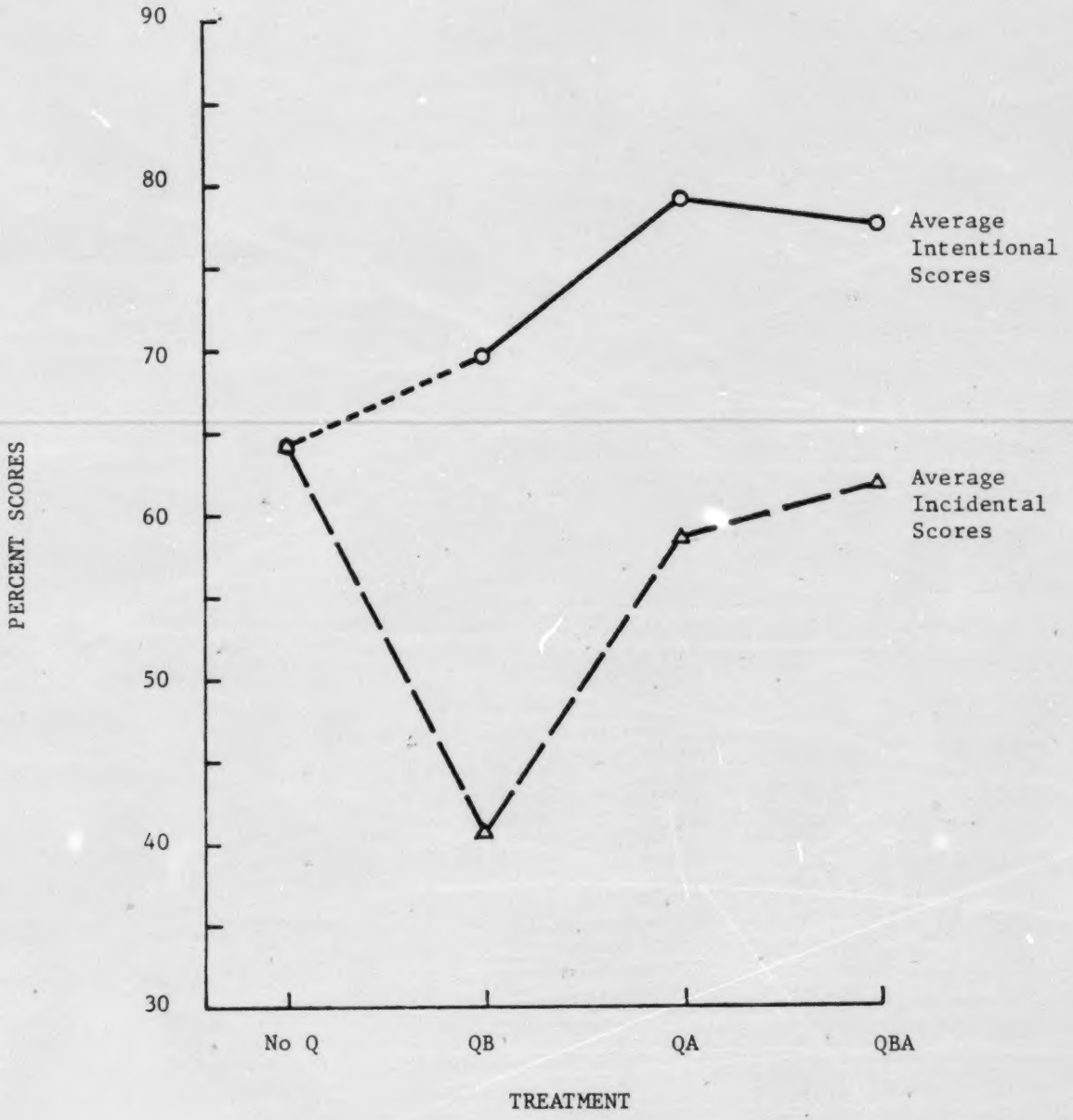

Figure 1: Total Intentional and Total Incidental Performance Across Treatment Groups

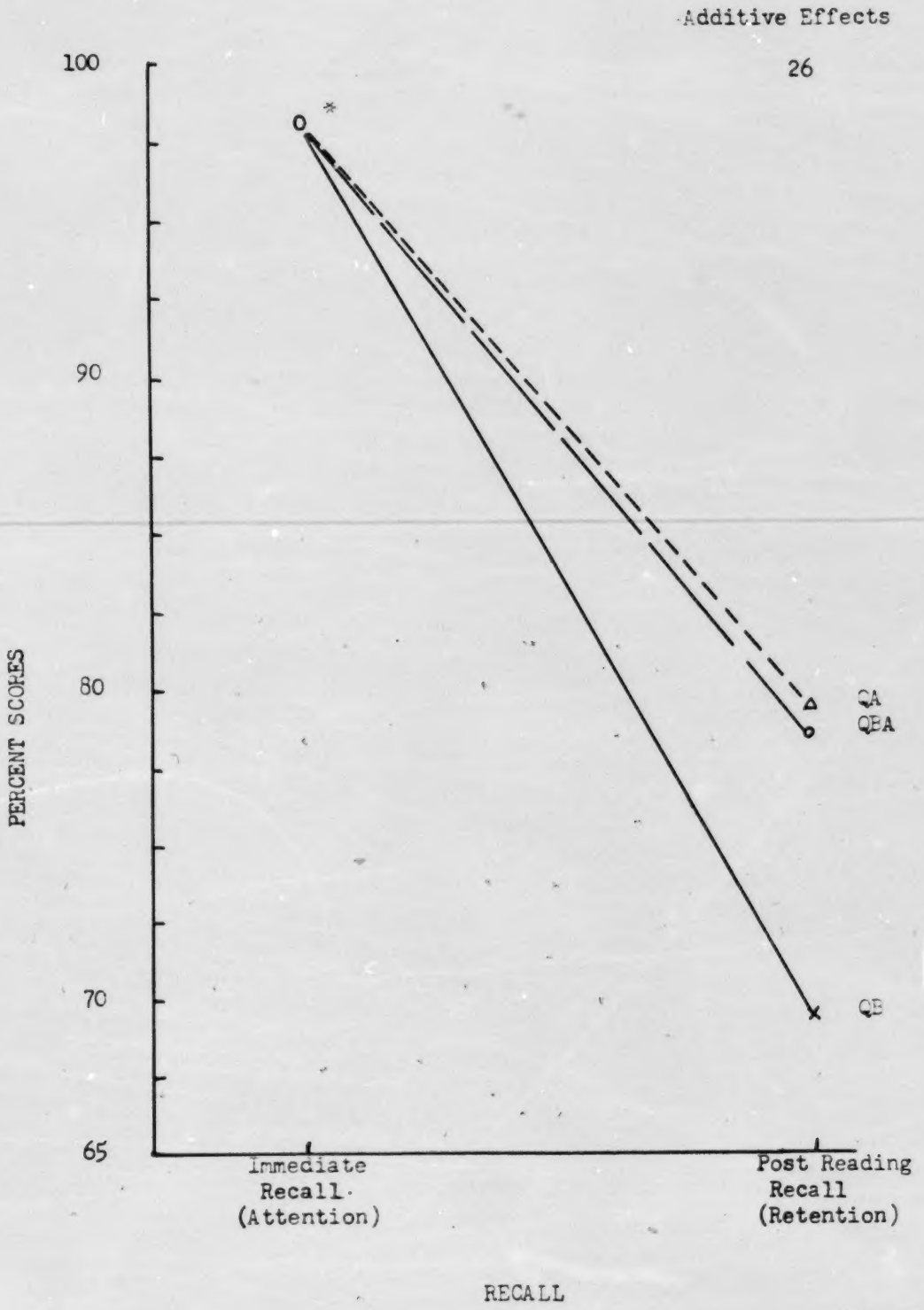

Figure 2: Performance indicators, "attention" and "retention" operations.

* Failure to find diffential affects on immediate recall allows us to simplify our data by using the "pooled" mean. This more clearly depict the non-differential effects of attention and the diffential effects of retention.

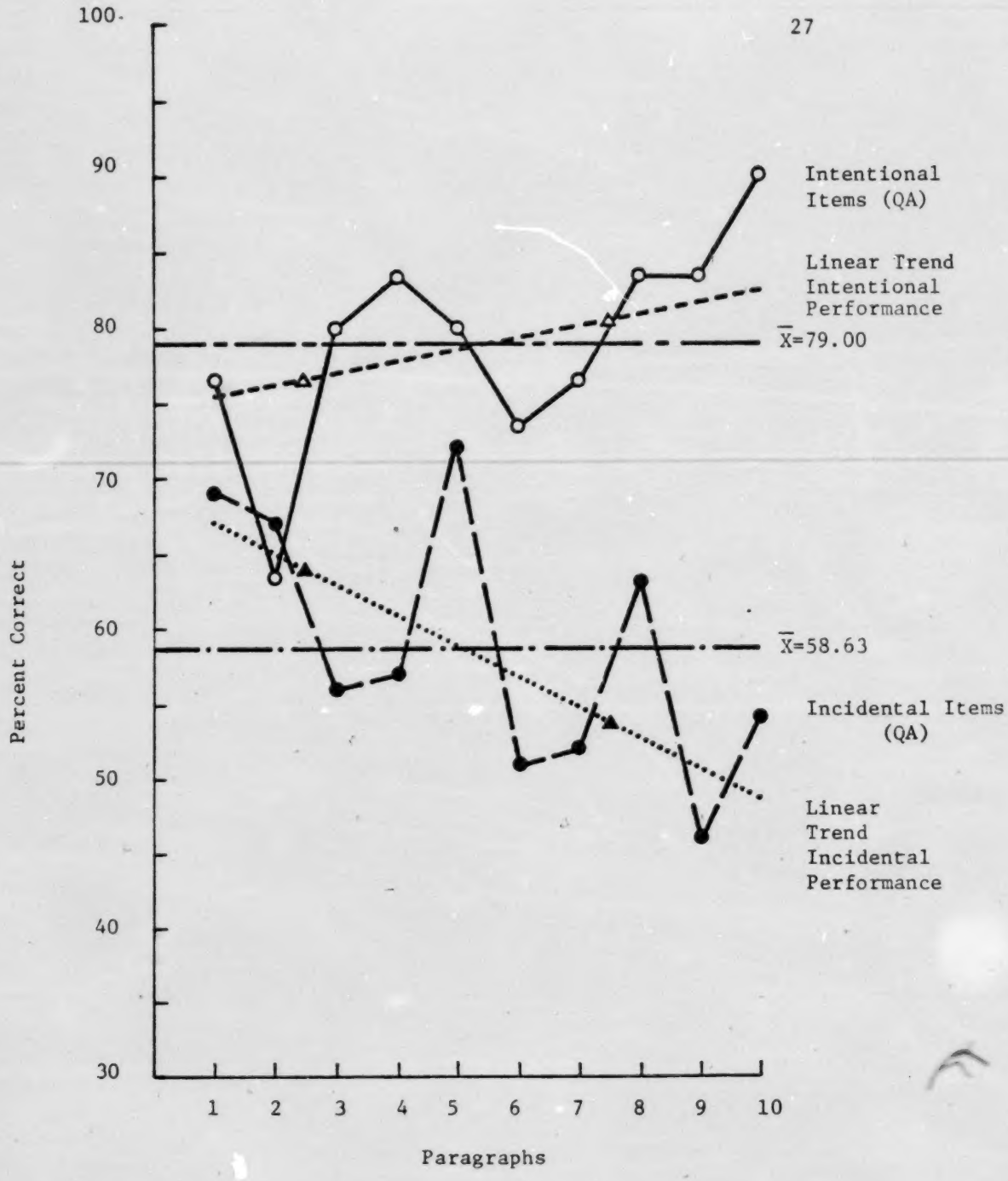

Figure 3: Performance Across Paragraphs Postquestions